APPENDIX D: SANTA CLARA VALLEY GROUNDWATER BASIN INFORMATION

Potential water sources for Coyote Valley include the Santa Clara Valley Groundwater Basin, which includes the Santa Clara and Coyote Sub-basins. Per the requirements of SB610, this Appendix describes the Santa Clara Valley Groundwater Basin, which a particular focus on the Coyote Sub-basin since it will supply a majority of the water to the Specific Plan. This appendix discusses groundwater management, lithography, discharge and recharge components, historic and current pumping and groundwater levels, storage, and groundwater quality.

Santa Clara Valley Groundwater Basin

Three linearly interconnected groundwater sub-basins make up the Santa Clara Valley Groundwater Basin: the Santa Clara, Coyote, and Llagas Sub-basins (Figure D-1). The Coyote Sub-basin is roughly 7 miles long and 2 miles wide, with a corresponding surface area of about 15 square miles, and contributes groundwater through the Coyote Narrows into the Santa Clara Sub-basin, which covers a surface area of 225 square miles. A groundwater divide at Cochrane Road separates northerly flow toward San Francisco Bay from water in the Llagas Sub-basin which drains to the south toward the Pajaro River and eventually Monterey Bay. (The actual location of the groundwater divide has historically been observed to move as much as one mile to the north or south of the designated boundary at Cochrane Road, due to hydrologic conditions.)

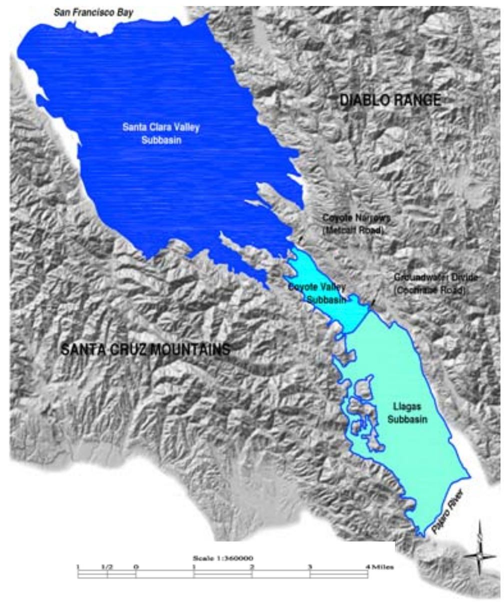


Figure D-1: Santa Clara Valley Groundwater Basin

Coyote Sub-basin

Stream flow in Coyote Creek used to recharge the local groundwater basin can be regulated by Coyote and Anderson reservoirs. Coyote Creek enters the Coyote Valley from the southeast at Anderson Reservoir. The creek crosses US 101 and meanders northward past Coyote Creek Golf Course to the Coyote Narrows. Several percolation ponds, operated by the SCVWD, are located along Coyote Creek to recharge the groundwater sub-basin in San José. Abandoned quarry ponds, which are also used for groundwater recharge, are located along the creek in the southeastern portion of the CVSP area. Toward the northwest end of the valley, discontinuous basin deposits of clay tend to keep ponds, including the Metcalf Percolation Ponds, and other low areas filled with perched groundwater, above the main saturated aquifer. Figure D-2 schematically shows groundwater management techniques within Coyote Valley.

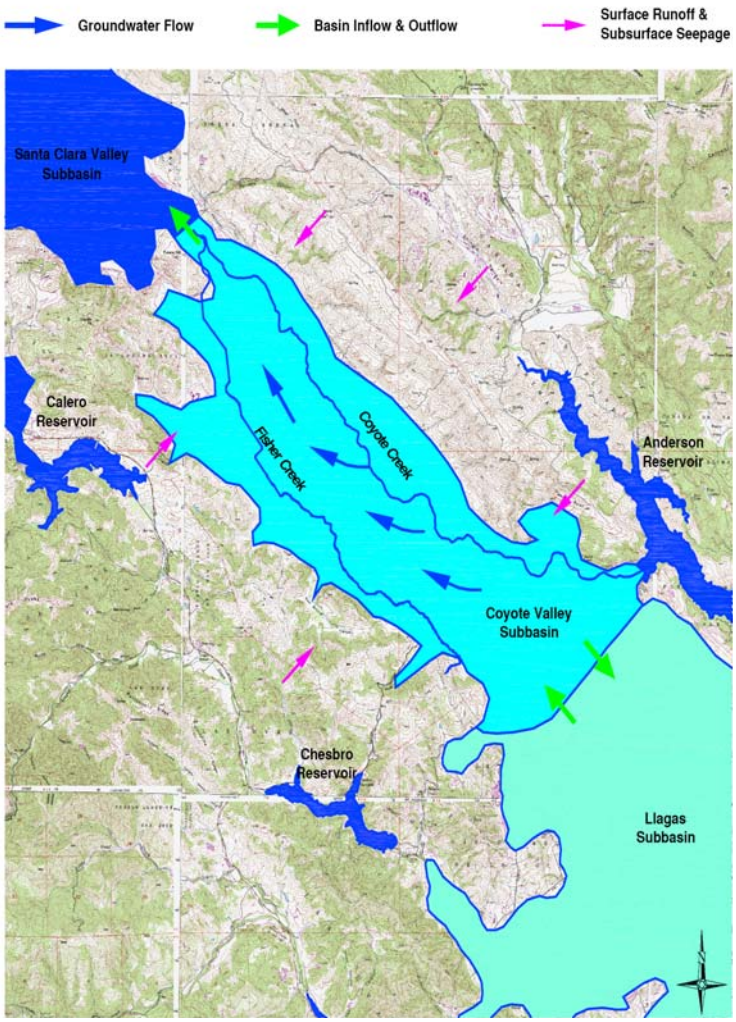


Figure D-2: Groundwater Management in Coyote Sub-basin

The Coyote Canal is located to the east of Coyote Creek and parallels Highway 101. This facility was built to help manage water resources in the valley, and in particular to deliver water around Coyote Creek's recharge area between Highway 101 and the Coyote Creek Golf Course because this recharge historically caused high groundwater levels in Coyote Valley. The Coyote Canal has historically been a tool to manage groundwater in Coyote Valley and prevent the loss of water supplies upstream of the Metcalf Percolation Ponds and the Santa Clara Sub-basin aquifer it recharges.

Several manmade ponds dot the study area, particularly near Coyote Creek where abandoned river gravel quarries remain filled with groundwater all year. Toward the northwest end of the valley, discontinuous basin deposits of clay tend to keep ponds and other low areas filled with perched groundwater, above the main saturated aquifer.

Basin Lithology. Lithography refers to the physical makeup of sediments and rocks, and how their depositional history affects groundwater resources. Figure D-3 shows the Coyote Basin's aerial geology, a transverse cross section, and a longitudinal cross section.

Water-bearing geologic formations in the Santa Clara Valley include rocks from the Pliocene through Holocene periods. The Franciscan Formation (shown in purple) – which outcrops in the Santa Cruz Mountains, the central part of the Diablo Range, near Coyote Narrows, and in the hills east of Coyote Creek – also underlies the Coyote Basin at depths of at least 160 feet. It is composed mostly of folded, faulted, and sheared marine sediments from the Jura-Cretaceous period, and has been estimated to be about 50,000 feet thick. The Franciscan Formation is not considered a significant source of groundwater, although DWR Bulletin 118-1 notes that it provided water to 25 wells in the South Santa Clara Valley (including the Coyote and Llagas Sub-basins) as of 1981.

The Santa Clara Formation (shown in green) is exposed in the hills to east side of Coyote Valley, and overlies the Franciscan Formation in much of the Coyote basin. It is a major water-bearing formation, possibly tapped by deeper wells in the Coyote Basin. It is composed of fairly well consolidated silt, clay, and sand with some zones of gravel, and may be inter-bedded with volcanic rocks in places. It is estimated to have a maximum thickness of around 1,800 feet. Available reports do not establish a depth to the surface for the upper surface, due to driller's log records not differentiating between it and overlying alluvial sediments. Valley fill materials (shown in tans and grey) include alluvial fans, older and younger alluvium, basin deposits, and stream deposits. These materials make up the uppermost and principal water-bearing strata in the Coyote sub-basin. Overall, the valley fill in Coyote is comprised of generally unconfined sand and gravel, with some discontinuous lenticular silt and clay deposits.

Alluvial fans that overly the Franciscan and Santa Clara formations are estimated to be between 3 feet and 25 feet thick. They are a heterogeneous mix of unconsolidated to semi-consolidated clay, silt, and sand, with some gravel lenses. Older and younger alluvium overly alluvial fans and older deposits, and are estimated at up to 125 and 100 feet thick respectively. They are composed of unconsolidated silt, sand, and clay deposited as ancient flood plain, with sandy gravel deposits occurring in areas of ancient stream channels (these are shown with grey coloration on the cross sections in Figure D-3). Older alluvium is distinguished from younger alluvium by its dense clayey subsoil which retards vertical movement of water and has low recharge potential. Groundwater is generally unconfined in the younger alluvium and ranges from unconfined to locally confined in the older alluvium. Within the older and younger alluvium deposits in the Coyote Sub-basin are two networks of interconnected buried stream channels left behind by an ancient Coyote Creek. The older network is found at elevations below about zero feet, and follows the path of a southward flowing Coyote Creek; while the upper system, found at elevations above about zero feet, follows a later, northward flowing Coyote Creek.

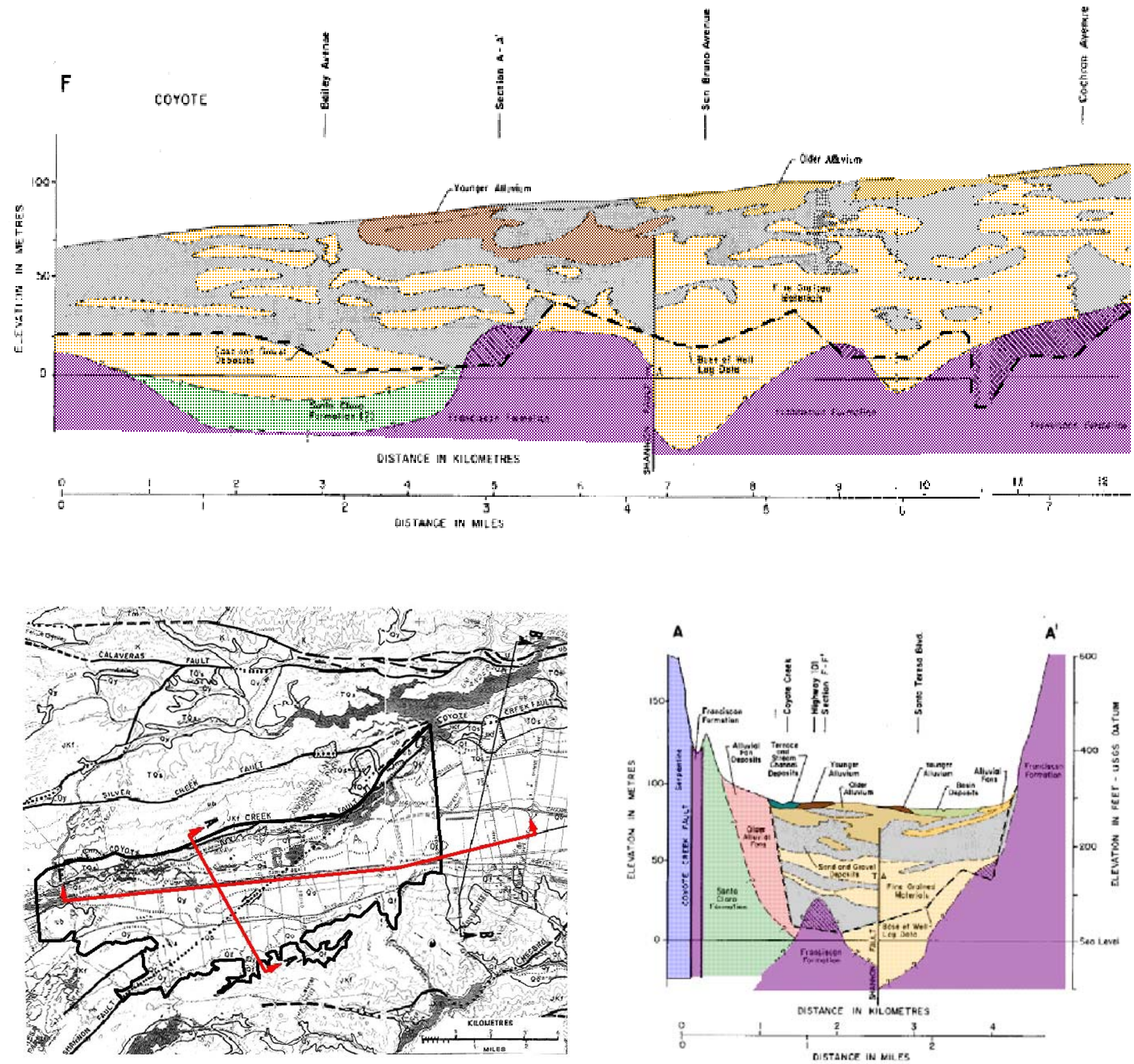


Figure D-3: Aerial and Cross Sectional Geology of Coyote Valley

Basin deposits are fine-grained unconsolidated silty and sandy clays, with areas of plastic and organic clays. Basin deposits are found in low-lying areas at thicknesses up to 100 feet in the Santa Clara Valley, and are specifically found in North Coyote. They have low infiltration rates, are prone to ponding during the rainy season, and can act as a confining layer to underlying deposits. Stream deposits are unconsolidated sand, gravel, and cobbles, with little or no silt and clay. They are up to 50 feet thick and occur in and around stream channels in the Coyote Basin. They have a high infiltration rate and facilitate the recharge of deeper water-bearing layers.

Essentially the valley floor is made up largely of permeable materials that allow for the free recharge of surface water (resulting from direct runoff during storms) into the deeper water bearing layers. Permeability throughout Coyote Valley is not necessarily uniform, and certain locations provide more natural groundwater recharge than others (the bed of Coyote Creek being a prime example). The general trend of soil permeability is shown in Figure D-4. Pink soil groups including shallow loess and sandy loam; green soil groups include clay loams, shallow sandy loam, and soil high in clay content; and blue soil groups include soils that swell when wet, heavy plastic clays and other soils affording little groundwater infiltration.

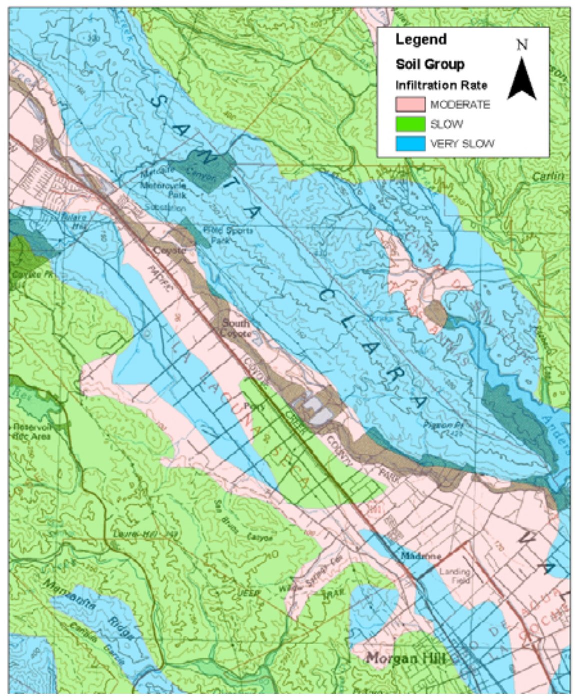


Figure D-4: Relative Surface Infiltration

Due to a lack of verifiable data for the area, the depth to bedrock of the basin is unconfirmed. DWR Water Bulletin 118-1 presents elevation contours of the lower surface of valley fill materials based on well driller's logs. These contours show the base of the alluvial deposits to range from elevation 0 to 200 feet; placing the Valley Fill depth at a maximum of about 390 feet.

Groundwater Basin Balance. Existing and historic conditions in the Coyote Valley Sub-basin are best examined through the concept of basin balance. A basin is said to be in balance when the volume of water entering a basin is equal to the volume of water leaving the basin, over a specified period of time (usually a year). This concept is also often referred to as a "groundwater budget". Should either the input or output of water from a basin fall out of balance, groundwater levels within that basin will rise or fall in response. Groundwater basins where the output of water exceeds the input of water over a number of years are said to be "mined". In 2000 CH2M-Hill prepared a Coyote Valley groundwater budget for the Metcalf Energy Center, representing average conditions from 1988 to 1999 (Figure D-5). This time period experienced wet, average and dry year conditions, and because the time frame experienced one half of a critical dry period, provides a relatively conservative water budget, which indicates an essentially balanced basin, with recent inflows exceeding recent discharge by about two percent.

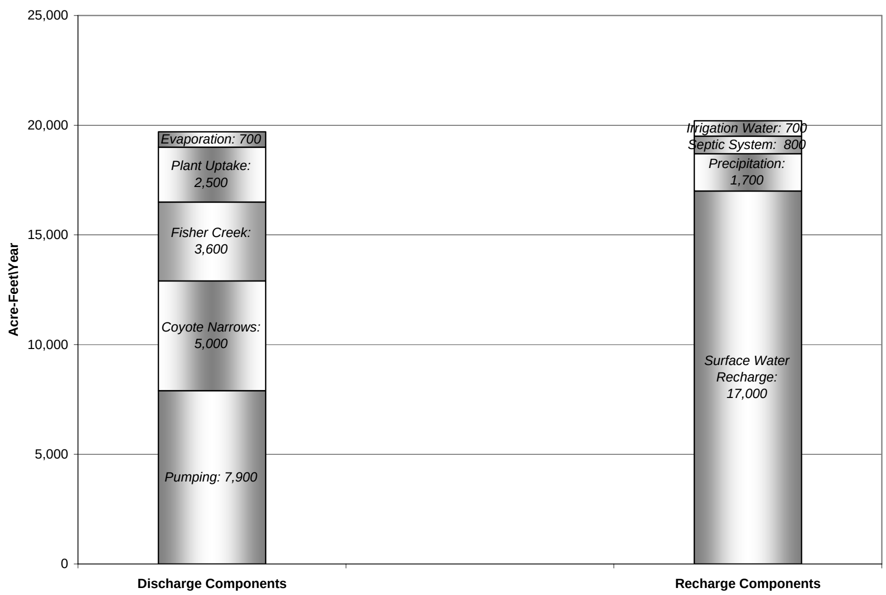


Figure D-5: Coyote Valley Groundwater Budget
(CH2M-Hill, 2000)

Discharge Components. Discharge components refer to water uses or losses within the groundwater basin. They include in order of magnitude: direct groundwater extractions (i.e. pumping); subsurface outflow through the Coyote Narrows; discharges to surface water (e.g. Fisher Creek); direct consumption by plants, and the direct evaporation of surface water.

The District has records for 619 production wells in Coyote Valley. Although many of the wells in Coyote Valley are not metered, the majority of groundwater used comes from metered wells. Where meter data is not available, groundwater production has been estimated using efficiency or flow testing, power use, and/or crop factors. Table D-1 summarizes District-reported pumping in Coyote Valley from 1989 to 2004. (Ref. Roger Pierno, SCVWD Groundwater Management Unit; and SCVWD *Urban Water Management Plan 2005*.)

Table D-1: Historic Groundwater Pumping in Coyote Valley

Year	Pumping (acre-feet)
1989	6,011
1990	6,609
1991	6,433
1992	6,152
1993	6,104
1994	6,537
1995	6,693
1996	6,592
1997	8,004
1998	6,918
1999	8,387
2000	7,894
2001	6,892
2002	6,721
2003	6,796
2004	7,290

Subsurface outflow is the discharge through Coyote Narrows and while difficult to quantify (since the discharge cannot be directly measured), is very important to the health of the Santa Clara Sub-basin to the north and the water supply situation in San José. Average annual flow through the Narrows has been estimated by others in the past:

6,200 acre-feet per year for 1983-84 (Harding Lawson Associates, 1985)
4,400 acre-feet per year for 1984-85 (SCVWD, 1989)
5,000 acre-feet per year based on hydrogeologic conditions (CH2M-Hill, 1992)

The natural condition of Coyote Creek is to lose water to the groundwater basin upstream of the Coyote Creek Golf Course since the natural gradient of the basin is away from Coyote Creek and toward Fisher Creek to the west and north. The underground basin becomes generally thinner and shallower near the Narrows, causing groundwater to influence surface water conditions. CH2M-Hill estimates that the base flow component of Fisher Creek is 300 acre-feet per month, or 3,600 acre-feet per year. This represents the flow of water in Fisher Creek not attributed to direct rainfall runoff. There does not appear to be a strong component of groundwater discharge to Coyote Creek, and CH2M-Hill neglected this in their groundwater budget.

Plants in wetland and riparian areas within Coyote Valley can directly use available soil moisture to build tissue. This type of plant is referred to as a phreatophyte, and CH2M-Hill assumed a consumption of 4 acre-feet per acre of riparian or wetland habitat to estimate a total direct consumption of 1,900 acre-feet per year for native plants.

The District is concerned with the maintenance of natural creek flows and wetlands in the face of changing water demand within Coyote Valley, and their proposed groundwater management scenarios reflect this concern.

Crops and other vegetation within shallow groundwater areas (especially Laguna Seca) also directly consume groundwater from the basin. Assuming the rate of use for these plants mimics water demand for irrigated grass pasture within interior valleys (45 inches per year); CH2M-Hill estimated an annual loss of 600 acre-feet for this discharge category.

Open water surfaces in Coyote Creek, Fisher Creek, various ponds, golf course lakes, and old gravel pits have been estimated to lose 740 acre-feet of water every year.

Recharge Components. Recharge components refer to water gains within the groundwater basin. They include in order of magnitude: direct surface water recharge (natural and artificial); the deep percolation of precipitation; septic system discharges to groundwater; and the deep percolation of irrigation return water.

Unmanaged natural sources of recharge to the Coyote Sub-basin include rainfall, pipeline leakage, net irrigation return flows to the basin, underground seepage from the surrounding hills, and infiltration of flow in streams which drain areas of the Santa Cruz Mountains to the West[1]. Of these, deep percolation of rainfall accounts for most of the natural inflow to Coyote[2]. Because irrigation returns and pipeline leakage are difficult to measure, the District estimates total natural recharge to the Coyote Sub-basin by tracking annual groundwater pumping and the

[1] DWR Bulletin 118-1
[2] SCVWD Groundwater Conditions 2001, p. 8

change in storage estimated from groundwater levels. Table D-2 presents estimates of natural recharge for four hydrologic scenarios used in groundwater supply planning.

Table D-2: Estimated Natural Groundwater Recharge

Hydrologic Scenario	Estimated Natural Recharge (ac-ft/year)
Wet Year	4,000
Long Term Average	2,600
Single Dry Year	1,600
Critical Dry Period	2,400

Source: SCVWD Urban Water Management Plan 2005, p 30.

The majority of basin recharge (85 percent) under current conditions is from direct surface water recharge. Coyote Creek and Coyote Canal are the only surface water bodies that can recharge water from outside of the basin limits (artificial recharge is discussed below). Available research indicates that Fisher Creek receives water from the groundwater basin, but does not provide appreciable recharge in return due to its relatively small watershed and the presence of a confining layer (particularly in the north). The open bodies of water (lakes, gravel pits, etc.) that evaporate water from the basin are also available to directly infiltrate rainwater in lesser amounts. (As described earlier, annual evaporation is more than double mean annual precipitation.)

The District also has the ability to facilitate enhanced groundwater recharge to all three of the Santa Clara County groundwater basins through 80 of its 90 miles of stream channels and 71 off-stream ponds. The recharge program consists of both releasing locally stored and imported water into District streams and ponds, and managing and maintaining the streams and ponds to ensure continued recharge. The District actively supplements natural recharge to the Coyote Subbasin with “artificial” recharge operations in Coyote Creek. Like natural recharge, artificial recharge of Coyote occurs through infiltration of streamflow in Coyote Creek.

The District manages the amount of water artificially recharging Coyote by releasing water stored in Anderson Reservoir to maintain streamflow during dry months and low streamflow periods. Artificial recharge volumes for calendar years 1998 to 2004 are presented in Table D-3, noting that there is roughly a 15 percent difference between these figures and the CH2M-Hill estimate for total surface water recharge in their water balance.

Table D-3: Artificial Recharge to Coyote Sub-basin[3]

Calendar Year	Artificial Recharge (acre-feet)
1998	8,180
1999	9,891
2000	8,042
2001	8,412
2002	11,737
2003	7,200
2004	8,500

Other sources of recharge include rainfall and agricultural irrigation water return. The California Department of Water Resources estimates that a little more than two inches of rainfall over the Coyote Valley floor reaches the groundwater aquifer through deep percolation, providing about 1,700 acre-feet of supply to the basin every year. About ten percent of agricultural irrigation water returns to the aquifer through deep percolation, and about half of all residential water uses from the aquifer return as septic system discharge. Septic discharges are filtered through sandy soils and unconsolidated deposits before reaching the water table, similar to a slow sand filtration system found in a water treatment facility.

Groundwater Levels. Groundwater levels respond to changes in the balance between groundwater recharge and withdrawal, and indicate the relative amount of water stored in an aquifer at a given point in time. The District maintains groundwater elevation data for monitoring wells in the Coyote Sub-basin dating back to 1937. Because most wells were designed as production wells, they are screened at multiple depths, and therefore elevation data represents an average of the conditions in the various water-bearing formations. A monitoring well at Palm Avenue has been selected as representative of groundwater basin trends over the longest period of time. Figure D-6 superimposes groundwater elevations at this monitoring well and a graph of long-term rainfall patterns as measured in San José.

[3] Personal communications w/ Roger Pierno, Groundwater Management Unit, SCVWD.

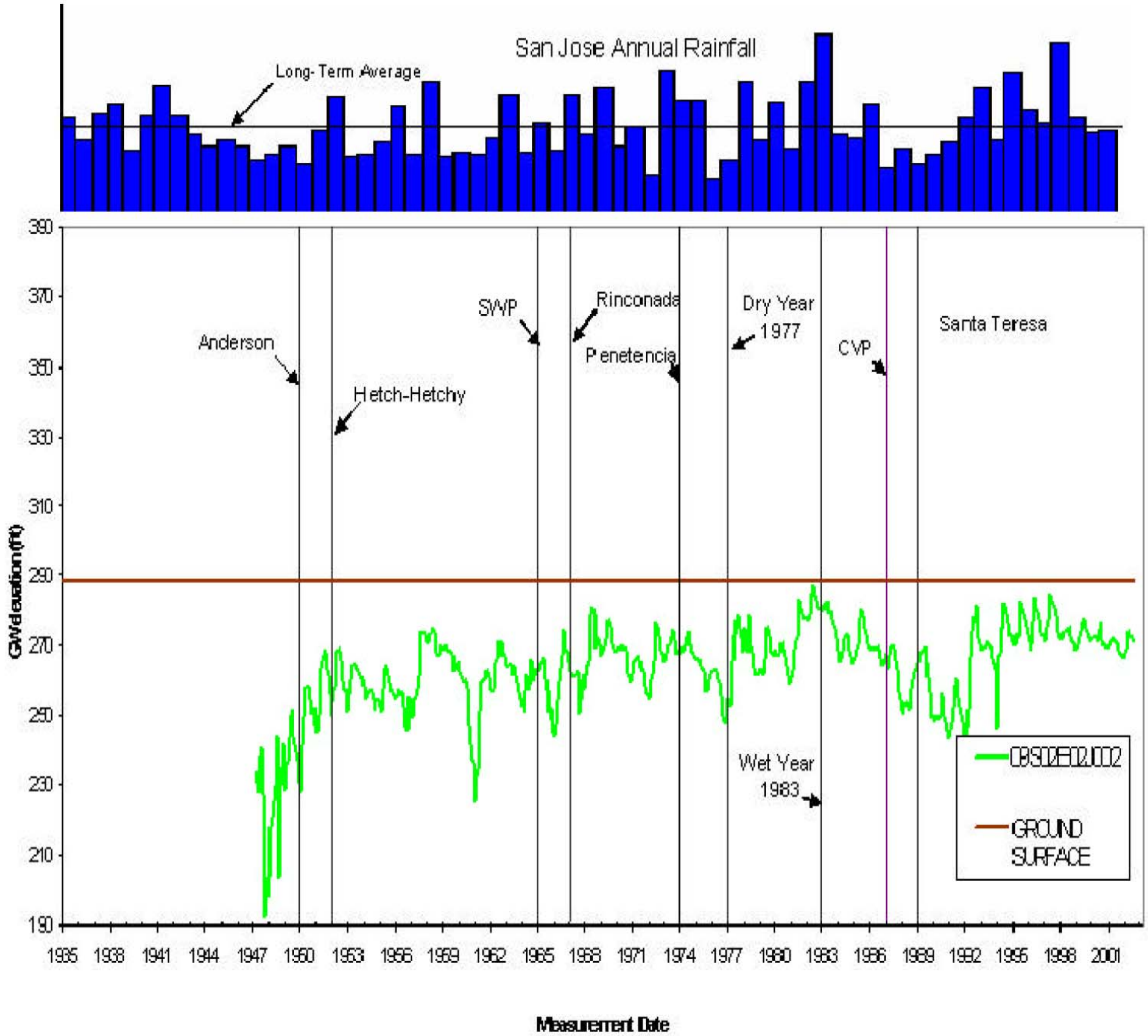


Figure D-6: Historic Groundwater Levels in Coyote Valley

As demonstrated in the groundwater elevation graph, groundwater levels in Coyote Valley are very responsive to the stimuli of rainfall and artificial recharge. By 1937, when the District began to monitor water levels in Coyote Valley, groundwater had been used as a water supply source for more than 80 years. Subsidence of nearly four feet had been recorded in San José; and the Almaden, Calero, Guadalupe, Stevens Creek, Vasona, and Coyote dams had been constructed to store excess winter streamflow for dry-month releases into recharge facilities. Countywide groundwater levels increased from the late 1930s into the beginning of the below-normal precipitation in 1944. Between 1944 and 1950, a combination of low precipitation and use of groundwater for almost all of the county's water needs corresponded to an extreme drop in groundwater elevations in Coyote. In 1950, construction of Anderson Dam was complete. In 1952 the county began importing Hetch-Hetchy water, however, the county population doubled between 1950 and 1960, and water levels in the northerly Santa Clara Sub-basin declined.

Levels in the Coyote Sub-basin remained relatively stable during this period, however. In the early 1960s the district contracted with the State for an entitlement of 100,000 acre-feet per year through the South Bay aqueduct. In 1967 the District began delivering surface water treated at the new Rinconada Water Treatment Plant (WTP) to north county residents, reducing groundwater extraction and allowing for some basin recovery. Between 1960 and 1970, the county population again doubled. In 1974 Penetencia WTP began delivering treated water to some county residents, reducing some of the demand for groundwater. In 1987 delivery of water from the Central Valley Project began, and in 1989 the Santa Teresa WTP began treating and delivering surface water.

Table D-4 summarizes long-term groundwater data for the Palm Avenue Index Well (Well Number 09S02E02J002 at ground elevation 287 feet, with a total of 623 measurements in the District's records beginning on Jan 14, 1948.)

Table D-4: Groundwater Levels at Palm Avenue Index Well

	Depth to Water (feet)
Average	23.5
Minimum	0.0
Maximum	95.1
Standard Deviation	12.3

Water levels in the Coyote basin respond quickly to changes in circumstances and precipitation. For example, the index wells show a substantial drop in water levels in response to the low precipitation of 1977; however by the fall of 1979, after a period of above-average rainfall, water elevations had recovered to pre-drought levels. Similarly, water levels throughout the basin increased substantially in response toe the above average precipitation of 1982-1983; but by the spring of 1985 after a period of below average rainfall, were back to pre-wet conditions.

Figures D-7 and D-8 show, respectively, the long-term average depth to groundwater (as measured in feet from the ground surface) during the fall and spring. Both fall and spring groundwater tables become shallower toward the Narrows. Note also that the long term average spring condition shows groundwater at the surface (depth 0) in Laguna Seca at the north end of Coyote Valley.

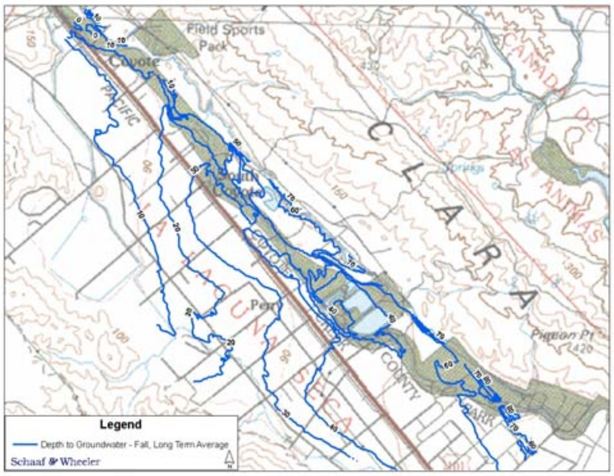


Figure D-7: Avg. Depth to Groundwater in Fall

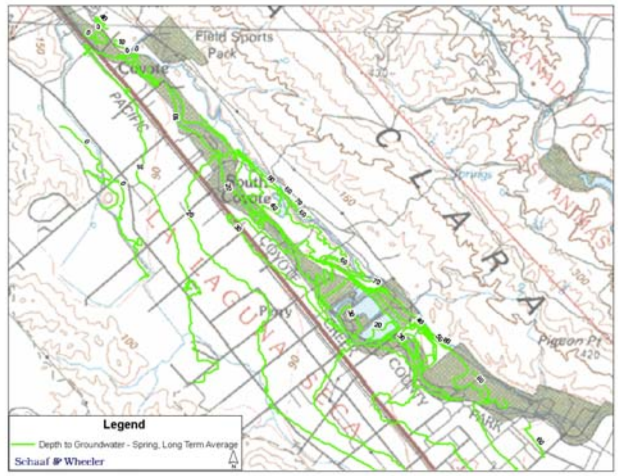


Figure D-8: Avg. Depth to Groundwater in Spring

Groundwater Storage. In April of 2002 the District released a report on a study of the operational storage capacity within the Coyote and Llagas sub-basins. Because the District has not always used a dynamic groundwater model to simulate conditions in the Coyote Basin, estimates of operational storage are made based on the volume between two sets of groundwater elevation surfaces in the basin. The District's analysis is based on groundwater surfaces from the drought of 1976-1977 and the wet conditions of 1982-1983. Two sets of specific yield values were used; one from DWR Bulletin 118, and another from previous estimates made by the District, assuming a constant specific yield is assumed for the entire vertical column under a particular node, ignoring differences in specific yield attributable to the heterogeneity of aquifer materials.

Using the two sets of specific yield values, the District estimates operational storage capacity in the Coyote Sub-basin to be between 23,000 and 33,000 acre-feet. Thus, if water is not recharged to the basin through rainfall, runoff and/or reservoir releases, the basin would run dry in one or two years with current average discharges.

Groundwater Quality. Protecting groundwater within the Coyote Valley Sub-basin (and hence subsurface flows to the north) from contamination and the threat of contamination is an important part of continuing groundwater management responsibilities for the District and City of San Jose. Overall groundwater quality is good in Coyote Valley, with levels of most contaminants monitored falling below maximum level standards for the various beneficial uses of groundwater as defined by the Regional Water Quality Control Board (Table D-5).

Nitrate is a problem to some extent in the Coyote Valley Sub-basin, and more of a problem within the Llagas Sub-basin to the south, where concentrations above the maximum contaminant level (MCL) of 45 mg/l (or parts per million) have been found in many private wells (Figure D-9). In response the District implemented a nitrate management program to monitor, track and manage nitrate contamination. Studies in 1992 and 1997 found that nitrate concentrations in the Llagas Sub-basin are generally increasing over time while concentrations in Coyote Valley have remained fairly constant.

Major sources of nitrate loading were found to be fertilizer used in agriculture, and animal and human waste generation. Although recently more agricultural land in the South County has been converted to residential use, nitrate concentrations in groundwater may continue to increase and or remain steady due to residual nitrate in the soil from prior use and the slow movement of water from the surface to the water table.

There are no public sewer systems within the Coyote Greenbelt and not all septic leach fields were approved by the County Department of Health Services when they were constructed. Seasonally high groundwater elevations during wet periods may have exacerbated the transmission of nitrate loading from sanitary leaching systems to water bearing formations and eventually to groundwater wells. Poor sanitary seals at individual well casings may also contribute to this problem.

Over half of the 600 private wells tested in the Llagas and Coyote Valley Sub-basins in 1997 exceeded the federal safe drinking water standard for nitrate, although all public supply water wells meet drinking water standards.[4]

[4] SCVWD Groundwater Management Plan 2001, p 41

Table D-5: Water Quality Data for Coyote Valley

Constituent	Coyote Sub-basin	Drinking Water Standard[5]	Agricultural Objective[6]
Aluminum (ug/l)	<50	1000	20000
Arsenic (ug/l)	<2	50	500
Barium (ug/l)	<126	1000	-
Beryllium (ug/l)	<1	4	500
Boron (ug/l)	<132	-	200
Bromide (ug/l)	.09 - .16	-	-
Cadmium (ug/l)	<1	5	500
Calcium (mg/l)	28-56	-	-
Chloride (mg/l)	27-35	500	355
Chromium (ug/l)	<12	50	1000
Copper (ug/l)	<50	1000	-
Fluoride (mg/l)	.14-.21	1.8	15
Hardness (mg/l)	205-330	-	-
Iron[7] (ug/l)	<5	300	20000
Lead (ug/l)	<5	50	10000
Magnesium (ug/l)	24-60	-	-
Manganese (ug/l)	<20	50	10000
Mercury (ug/l)	<1	2	-
Nickel (ug/l)	<10	100	2000
Nitrate (mg/l)	10-47	45	135[8]
Selenium (ug/l)	<5	50	20
Silver (ug/l)	<10	100	-
Sodium (mg/l)	22-28	-	-
Specific conductance (uS/cm)	373-680	1600	3000
Sulfate (mg/l)	31-52	500	-
Total Dissolved solids (mg/l)	330-400	1000	10000
Zinc (ug/l)	<50	500	10000

Source: SCVWD Groundwater Conditions 2001 pg 46

[5] Maximum contaminant Level (MCL) specified in Title 22 of the California Code of Regulations
[6] Agricultural water quality objective in the 1995 Water Quality Control Plan for the San Francisco Bay Basin, Regional Water Quality Control Board
[7] Detection limit for iron varied from 5 ug/L to 100 ug/L..
[8] Nitrate Agricultural Objective: 30mg/L NO3 +NO@ (as N), approximately equal to 135mg/L

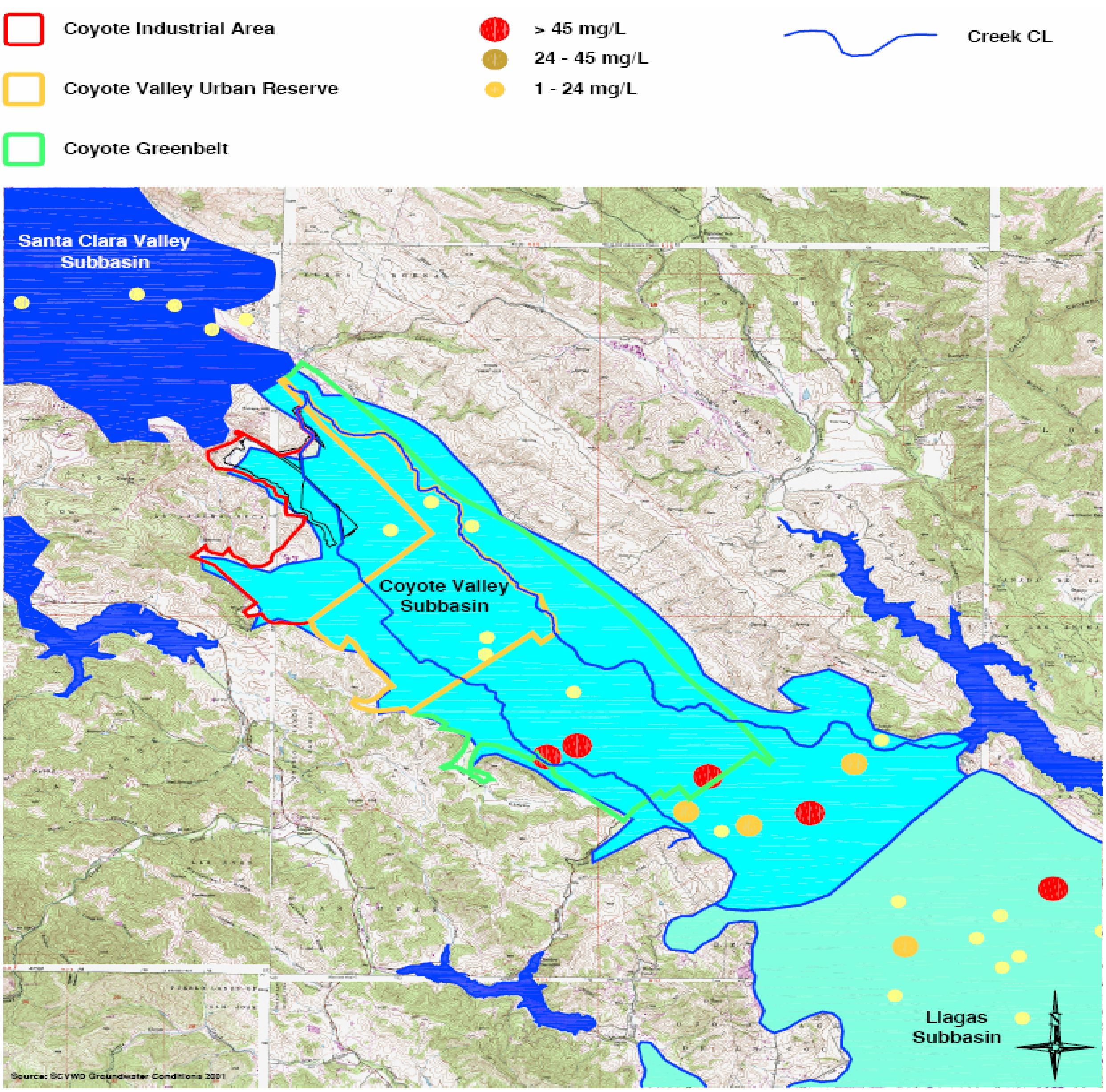
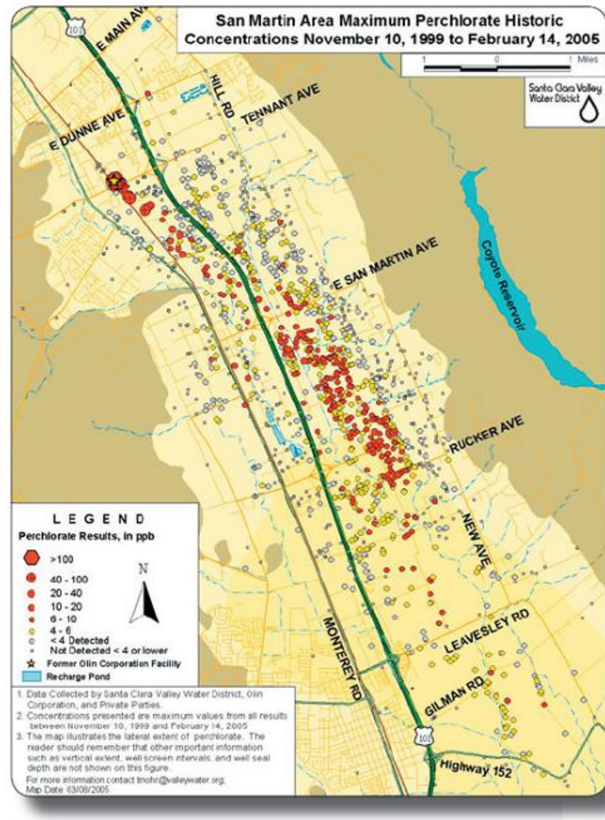


Figure D-9: Nitrate Concentrations (mg/l) in and Near Coyote Valley

Perchlorate, a chemical used in rocket fuel and highway flares, has been detected in the Llagas Subbasin south of Coyote Valley, contaminating wells in southeast Morgan Hill, San Martin and a few in north Gilroy. The contamination has been traced to a highway flare manufacturing plant operated by Olin Corporation from 1956 to 1997 on Tennant Avenue in Morgan Hill. At one time, it was believed that the contaminated groundwater flowed only southeast from the site of initial contamination. (Coyote Valley is about two miles to the northwest.) However, more recent information indicates that the chemical can migrate north in some gradients or sections.[9] The perchlorate situation is closely monitored by the District and affected cities. Figure D-10 shows contamination as of February 2005.



Groundwater testing results through February 14, 2005

Figure D-10: Perchlorate Concentrations in South Santa Clara County

Future changes in groundwater pumping distribution or extraction rates could affect the migration of contaminants by changing subsurface hydraulic gradients. The creation of local pumping troughs in response to higher demands is one example of a potential adverse impact. The local trough can affect pumping levels at adjacent wells and/or change the migration of contaminant plumes. This reiterates the importance of groundwater management in the Coyote and Llagas Sub-basins.

Detailed Groundwater Modeling. In response to the estimate of limited local basin storage and the desire to preserve groundwater levels and groundwater quality, the District prepared a Water Supply Availability Analysis for the CVSP in April 2005 (see Appendix E) using detailed numeric modeling techniques to assess the ability for future water retailers to extract groundwater from the Coyote Sub-basin to supply projected CVSP demands without adversely impacting other users in that basin, or the neighboring two groundwater basins; either as reflected in long-term groundwater levels or groundwater quality.

[9] Lawrence Livermore National Laboratory, “California Aquifer Susceptibility: A Contamination Vulnerability Assessment for the Santa Clara and San Mateo County Groundwater Basins,” 2002, p. 17

Santa Clara Sub-basin

Groundwater from the Coyote Sub-basin moves north through the Coyote Narrows to recharge the Santa Clara Sub-basin at the Coyote (aka Metcalf) ponds. The Santa Clara Sub-basin underlies a surface area of 225 square miles and is made up of permeable valley fill alluvium. The sub-basin's eastern and western geologic boundaries are formed by the impermeable bedrock of the Diablo Range and Santa Cruz Mountains, respectively. The basin's northern geologic boundary is formed by contact with thick low permeability Bay Mud deposits at San Francisco Bay, and the southern geologic boundary is the artificially defined Coyote Narrows described previously. The northwestern (San Mateo Sub-basin) and northeastern (Niles Cone Sub-basin) boundaries are also somewhat arbitrary and institutional, generally coinciding with Santa Clara County's borders. The sub-basin's bottom boundary is formed by bedrock or consolidated sediments of very low permeability.

Ground surface elevations above the groundwater basin vary from sea level at San Francisco Bay to about 280 feet at the Coyote Narrows, and the basin floor gradually slopes from the southern edges to the northern basin interior. The sub-basin is drained by Penetencia, Berryessa and Coyote Creeks, whose tributaries originate in the Diablo Range; and Permanente, Stevens, and San Tomas Aquino Creek and the Guadalupe River, whose tributaries originate in the Santa Cruz Mountains.

Basin Lithology. The Santa Clara sub-basin is a large depression filled with alluvium that has washed down from the surrounding mountains over the millennia. Alluvium is comprised of unconsolidated sediments such as gravel, sand, clay and silt. Santa Clara's alluvium ranges in thickness from about 200 feet at the Coyote Narrows to over 1,300 feet in the valley interior.

The sub-basin's alluvium is generally divided into Holocene deposits (more recent than 10,000 years old) and Pleistocene deposits (1.8 million to 10,000 years old). The younger deposits consist primarily of clay silt and sand occurring in discontinuous lenses roughly 50 to 75 feet below the ground surface near the center of the sub-basin. Most of the sub-basin's deposits are Pleistocene era, comprised of unconsolidated and inter-fingered lenses of clay, silt, sand and gravel. The Pleistocene deposits lie on top of the Santa Clara Formation.

Figure D-11 shows a cross section of the Santa Clara Sub-basin roughly from the vicinity of Coyote Narrows (actually slightly north of the Narrows) along Coyote Creek to the southeastern end of San Francisco Bay near Milpitas.

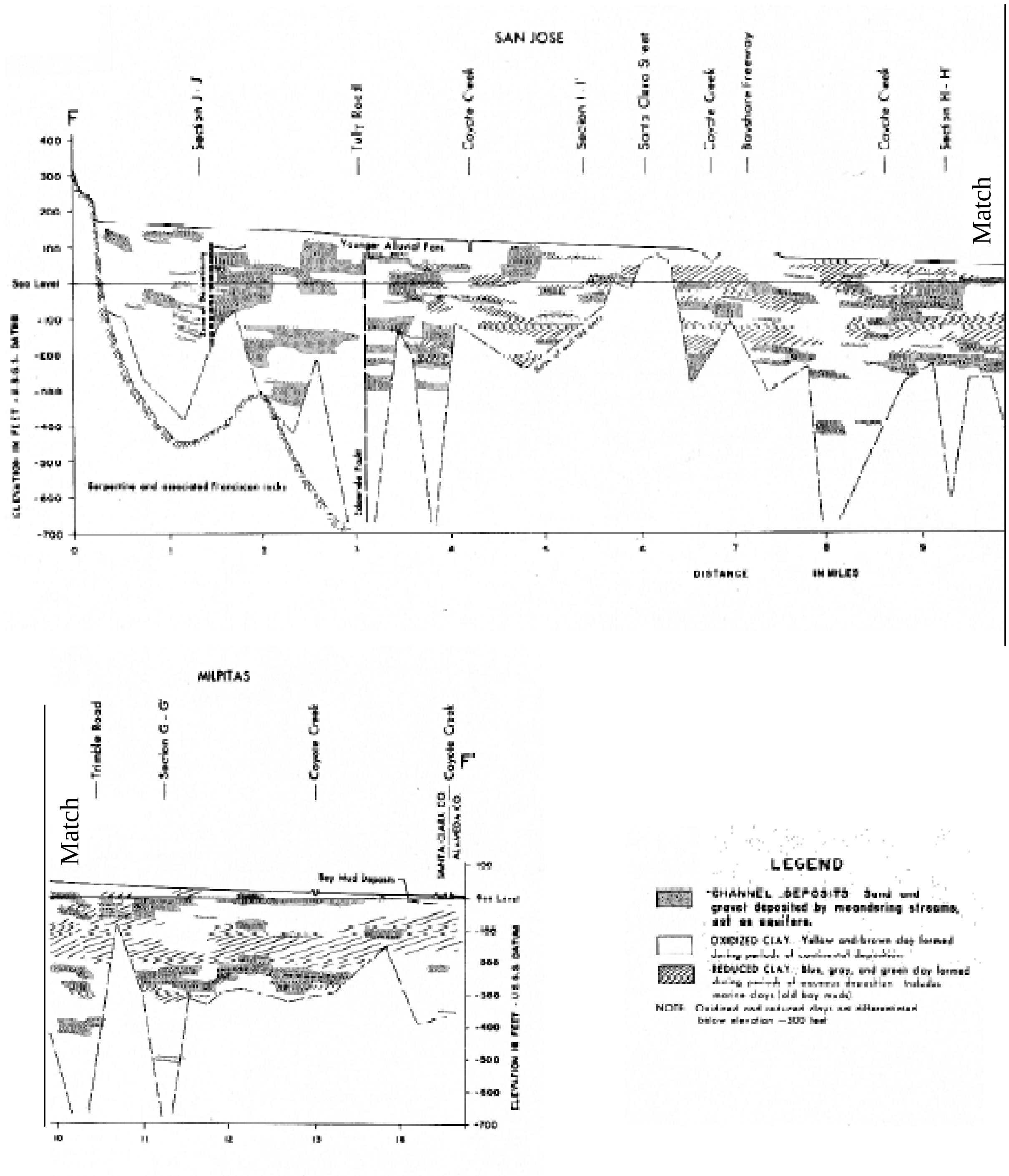


Figure D-11: Santa Clara Sub-basin Lithology (DWR Bulletin 118, 1981)

Hydrogeology. The Santa Clara Sub-basin consists of a series of stacked alluvial aquifers and aquitards that collectively have fairly well defined boundaries in the lateral direction. The bottom boundary is less well-defined due to a lack of depth-to-bedrock information in the center of the sub-basin. Hydrogeologically, the sub-basin is generally divided into confined and unconfined areas and a zone of special concern containing saline water of poor quality (SCVWD, 1989). Aquifer materials on top of a thick clay layer are considered unconfined (water table at atmospheric pressure), while aquifer materials beneath the thick clay layer are confined, or under hydrostatic pressure.

The principal aquifer in the sub-basin is within the younger alluvium found along the inner and tributary valleys (Iwamura, 1995). The unconfined recharge area includes alluvial fans and fluvial (stream) deposits found along the edge of the sub-basin where high lateral and vertical permeabilities allow surface water to infiltrate into the water bearing aquifer. The confined area is located in the northern and central part of the sub-basin and is characterized by upper and lower aquifers divided by discontinuous and laterally extensive low permeability materials such as clays, silty clays, silts and silty sands that restrict the vertical flow of groundwater (SCVWD, 2006). Figure D-12 shows confined and unconfined aquifers, and the zone of special concern.

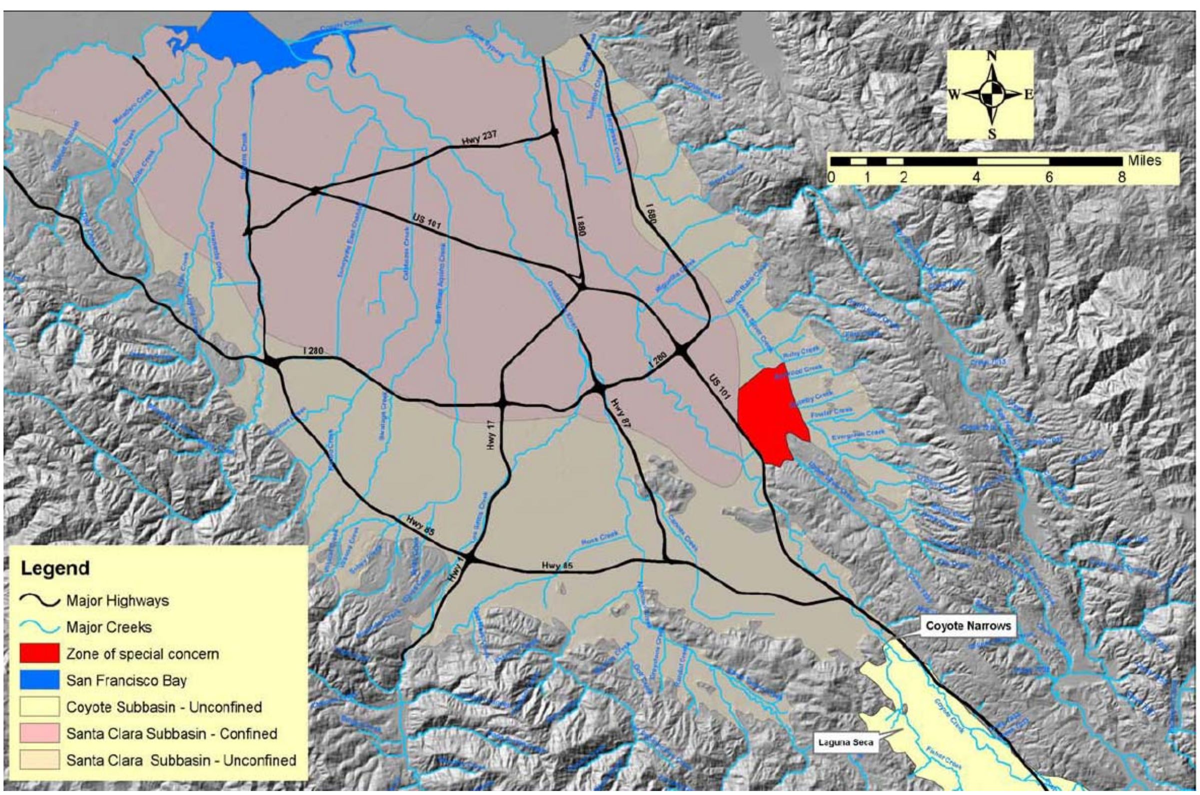


Figure D-12: Santa Clara Groundwater Sub-basin Aquifers (SCVWD, 2006)

Groundwater Management in Santa Clara Sub-basin. Potential water retailers for Coyote Valley all draw groundwater from both confined and unconfined areas within the Santa Clara Sub-basin. Significant pumping of this groundwater basin at the turn of the previous century resulted in widespread land subsidence within the interior of the sub-basin (up to 13 feet cumulatively in San Jose). Aggressive groundwater management by the Santa Clara Valley Water District essentially halted the land subsidence by 1969 (SCVWD, 2006). This was achieved through the importation of surface water (e.g. Central Valley Project), artificial recharge and aquifer system management, which continue to this day. Figure D-13 shows the effects of groundwater management on water levels over the last century.

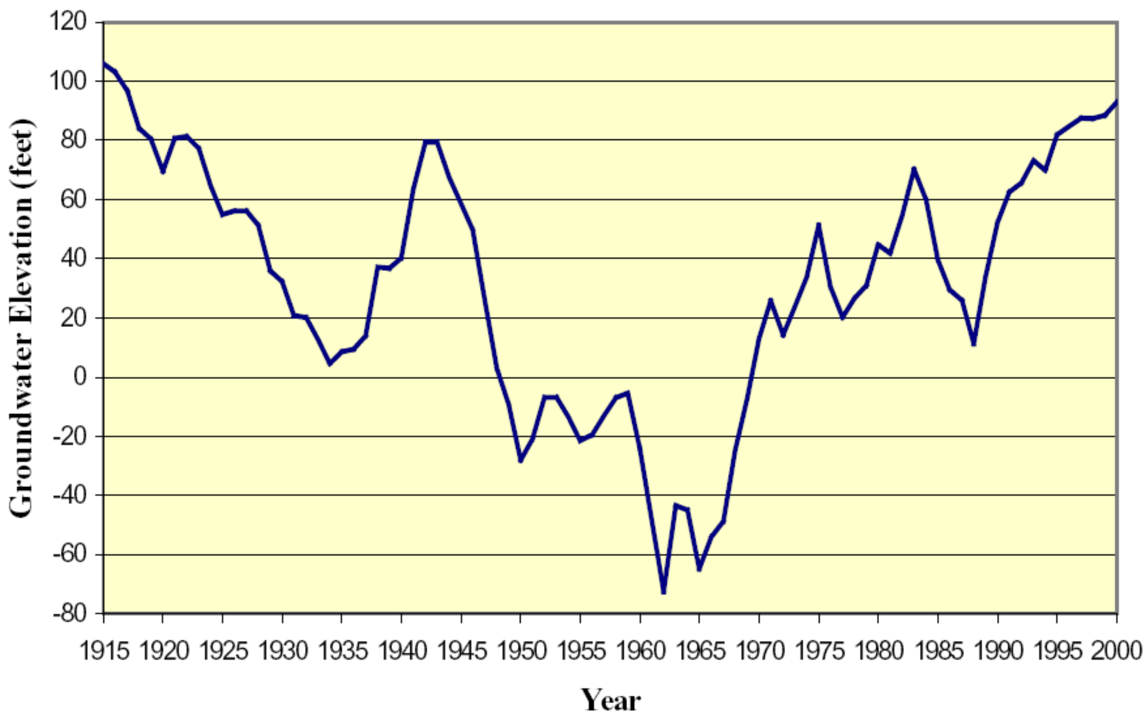


Figure D-13: Impact of Groundwater Management in Santa Clara Valley (SCVWD, 2001)

If groundwater pumping exceeds natural recharge, the District operates on-stream and off-stream artificial groundwater recharge facilities in the unconfined zone to replenish groundwater storage and maintain stable groundwater elevations and piezometric surfaces. Table D-6 lists recent annual groundwater production and artificial recharge within the Santa Clara Sub-basin.

Table D-6: Recent Recorded Groundwater Pumping in Santa Clara Sub-basin[10]

Year	Groundwater Pumping (acre-feet)	Artificial Recharge (acre-feet)
2001	115,400	98,700
2002	104,800	71,660
2003	96,600	74,800
2004	105,716	66,700
2005	87,467	70,100

Groundwater Storage. The Santa Clara Valley Water District estimates that the operational storage capacity of the Santa Clara Sub-basin is 350,000 acre-feet.[11] Figure D-14 provides a schematic of how this operational storage relates to the District's overall water supply system on a County-wide basis (SCVWD, 2005).

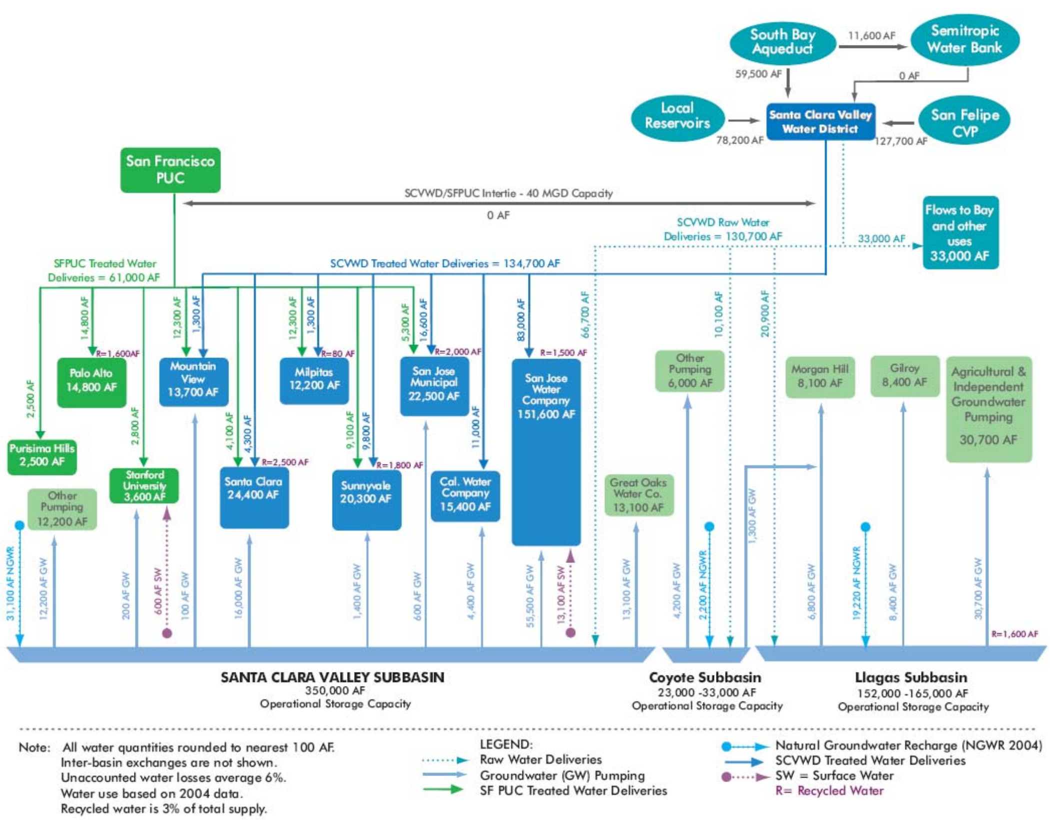


Figure D-14

10 Information Compiled by Santa Clara Valley Water District

11 SCVWD, 2005 UWMP, pg. 23.

Groundwater Quality. The quality of water extracted from the Santa Clara Sub-basin is generally good and suitable for a variety of domestic, commercial, industrial and agricultural uses. Drinking water standards are met at public supply wells without the need for additional treatment.

The few known water quality problems are limited to high mineral salts within the upper aquifer zone along San Francisco Bay; the lower aquifer zone underlying Palo Alto to the northeast; and the southeastern part of the forebay area of the Santa Clara Sub-basin. Elevated nitrate concentrations are only sporadically observed in the Santa Clara Sub-basin, and the overall nitrate problem is not as pronounced as in the Coyote Valley and Llagas Sub-basins (as previously described for the former).

Although there are a relatively large number of EPA Superfund sites within Santa Clara County, there are few groundwater supply impacts from chemicals at these sites. Volatile organic compounds (VOCs) are intermittently detected at trace concentrations from public supply wells.

Table D-7 provides groundwater quality data for the Santa Clara Sub-basin.

Table D-7: Water Quality Data for Santa Clara Sub-basin

Constituent	Santa Clara Sub-basin		Drinking Water Standard[12]	Agricultural Objective[13]
	Principal Aquifer	Upper Aquifer		
Aluminum (ug/l)	6-18	23-97	1000	20000
Arsenic (ug/l)	0.7-1.2	1.2-3.7	50	500
Barium (ug/l)	141-161	60-220	1000	-
Boron (ug/l)	115-150	200-523	-	500
Cadmium (ug/l)	<1	<0.5	5	500
Chloride (mg/l)	40-45	92-117	500	355
Chromium (ug/l)	6-8	0.5-1.8	50	1000
Copper (ug/l)	1.9-4.4	0.3-1	1000	-
Fluoride (mg/l)	0.13-0.16	0.15-0.3	1.8	15
Iron[14] (ug/l)	10-38	40-160	300	20000
Lead (ug/l)	0.2-1.1	<0.5	50	10000
Manganese (ug/l)	0.15-1.5	120-769	50	10000
Mercury (ug/l)	<1	<0.2	2	-
Nickel (ug/l)	1.8-3.4	4-10	100	2000
Nitrate (mg/l)	15-18	0.002-4	45	135[15]
Selenium (ug/l)	2.5-3.8	0.4-2	50	20
Silver (ug/l)	<5	<0.5	100	-
Sodium Adsorption Ratio	0.89-1.26	1.23-3.84	-	9
Specific conductance (uS/cm)	596-650	1090-1590	1600	3000
Sulfate (mg/l)	37-41	106-237	500	-
Total Dissolved solids (mg/l)	366-396	733-1210	1000	10000
Zinc (ug/l)	3-8	3-13	500	10000

Source: SCVWD Groundwater Management Plan (2001) pg 15

[12] Maximum contaminant Level (MCL) specified in Title 22 of the California Code of Regulations
[13] Agricultural water quality objective in the 1995 Water Quality Control Plan for the San Francisco Bay Basin, Regional Water Quality Control Board
[14] Detection limit for iron varied from 5 ug/L to 100 ug/L..
[15] Nitrate Agricultural Objective: 30mg/L NO3 +NO@ (as N), approximately equal to 135mg/L